

FORM PTO-1390
(REV. 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

Costa 2-2-3

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/936673

INTERNATIONAL APPLICATION NO.

PCT/GB00/00936

INTERNATIONAL FILING DATE

March 14, 2000

PRIORITY DATE CLAIMED

March 15, 1999

TITLE OF INVENTION

Telecommunications Signalling Using the Internet Protocol

APPLICANT(S) FOR DO/EO/US

Mauro Costa, Emiliano Antonio Mastromartino, Luca Salgarelli, Sutha Sivagnanasundaram

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:

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U.S. APPLICATION NO. 09/936673		INTERNATIONAL APPLICATION NO. PCT/GB00/00936		ATTORNEY'S DOCKET NUMBER Costa 2-2-3	
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21. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. **\$1000.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO. **\$860.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO. **\$710.00**

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4). **\$690.00**

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4). **\$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =

Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$
Total claims	6 - 20 =	0	x \$18.00	\$ 0
Independent claims	4 - 3 =	1	x \$80.00	\$ 80.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ \$270.00
TOTAL OF ABOVE CALCULATIONS =				\$ 350.00
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				+ \$ 0
SUBTOTAL =				\$ 1210.00
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 0
TOTAL NATIONAL FEE =				\$ 1210.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 0
TOTAL FEES ENCLOSED =				\$ 1210.00
				Amount to be refunded: \$
				charged: \$

21. ☒ The following fees are submitted:

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TOTAL OF ABOVE CALCULATIONS =				\$ 350.00
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SUBTOTAL =				\$ 1210.00
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$ 0
TOTAL NATIONAL FEE =				\$ 1210.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 0
TOTAL FEES ENCLOSED =				\$ 1210.00
				Amount to be refunded: \$
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a. ☐ A check in the amount of \$ _____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 12-2325 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 12-2325. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Docket Administrator

Lucent Technologies Inc.

Room 3J-219

101 Crawfords Corner Road

Holmdel, NJ 07733-3030

Christopher N. Malvone

SIGNATURE

Christopher N. Malvone

NAME

34,866

REGISTRATION NUMBER

5 TELECOMMUNICATIONS SIGNALLING
 USING THE INTERNET PROTOCOL

This invention relates to telecommunications signaling using the Internet protocol, particularly when the telecommunications signaling is Signaling System
10 number 7.

Signaling information needs to be exchanged between network nodes in order to operate the network properly. These requirements make signaling an extremely delicate information, which has to rely on reliable and secure transport mechanisms to ensure that messages are transferred uncorrupted and to guarantee the appropriate level
15 of protection against network failures of any sort.

Traditional telecommunications networks have adopted the Signaling System Number 7 (SS7) as the international standard for common signaling. This is a well-known technology and is used throughout the world both in cellular and fixed networks, and SS7 networks have been proved to be ideal for traditional telephone
20 networks. Internet traffic does not make use of SS7. As a result of the explosion of the Internet, the associated protocols (based on the Internet Protocol (IP)) are becoming ubiquitous and techniques to transfer real-time and mission critical applications using IP are being proposed in the relevant standards organizations. The major drawback typically associated with IP is its unreliability. Traditionally to obtain
25 reliable service in transferring data over an IP network the use of TCP (Transport Control Protocol) was the only choice. But the TCP offers only a best effort type of service to its user. In clear terms this means that the protocols themselves have not been originally designed to satisfy telephone telecom network -like requirements. Background information on signaling protocols and Internet protocols can be obtained
30 from the following documents:

Multi Network Datagram Transmission Protocol (MDTP) – IETF Internet-Draft, Motorola, 15th February 1999;

A Simple SCCP Tunneling Protocol (SSTP), IETF, Internet-Draft, Ericsson,
30th November 1998;

35 Architectural Framework for Signaling Transport, Ericsson, February 1999.

The problem of transferring real-time critical information. e.g.

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telecommunications data, over the Internet Protocol has been addressed in different ways. This specification relates to the requirements that SS7 users place on the underlying network. General solutions to the problem have been proposed which require the specification of new protocols whose main purpose is to provide fault tolerant reliable/unreliable data transfer between communicating processes over IP networks. These protocols are generic and do not assume specific translation or adaptation functions from/to SS7 protocols.

Another category of solutions includes adaptation layers specifically designed to adapt/shield SS7 users from the underlying IP networks.

The first category of solutions (i.e. generic protocols) are typically rather complex; they are in fact typically conceived for use in the Internet as a distributed geographical network. They have to incorporate reliability and fault management characteristics to compliment the existing Internet Protocols. They have also to include full routing and addressing mechanisms. These solutions are not suited to simple network topology, like point-to-point links arrangements.

The second category of solutions (additional protocols which act as adaptation layers) are located between existing SS7 protocols and existing Internet Protocols, and they have the purpose of shielding the SS7 user from the underlying network. These approaches are powerful but they are mainly conceived as straightforward adaptation protocols to be used in a geographical network, at the boundaries between SS7 domains and IP domains or when inter-working between the two worlds is necessary. Overall, these protocols or adaptation layers have to be inserted between existing protocols like SCCP (Signalling Connection Control Protocol) and TCP. Because of this, they add complexity to the system and are not suited for simple network topology arrangements, for example cellular networks.

In US5 793 771 MCI Communications Corporation, a system and method for protocol translation are provided, but the disclosure does not relate to systems operating Internet Protocol.

According to the invention method of providing a user of a telecommunications network with Signalling System Number 7 functionality, the network operating Internet Protocol and at least one of Transport Control Protocol and

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User Datagram Protocol and having between the user and the Core Network of the telecommunications network at least one interface, characterised by providing between the user and the Internet Protocol an interface protocol layer AP, said interface protocol layer interfacing with at least one of Transport Control Protocol and User Datagram Protocol whereby Signalling System Number 7 information is transmitted across said at least one interface.

Also according to the invention a telecommunications network comprising a Core Network CN and at least one network user and between the user and the Core Network at least one interface, the network operating Internet Protocol and at least one of Transport Control Protocol and User Datagram Protocol, characterised by an interface protocol layer AP between the user and the Core Network, said interface protocol layer being arranged to interface with at least one Transport Control Protocol and User Datagram Protocol whereby Signalling System Number 7 functionality is provided to the user.

Further according to the invention a Base Station Controller for a telecommunications network having a protocol stack comprising a BSS Management Application Part; a Direct Transfer Application Part Distribution Function; at least one of User Datagram Protocol and Transport Control Protocol and Internet Protocol; characterised in that there is an interface protocol layer AP between the Distribution Function Transport Control Protocol/User Datagram Protocol.

Yet further according to the invention a Radio Network Controller for a telecommunications network having a protocol stack comprising Radio Access Network Application Part; at least one of User Datagram Protocol and Transport Control Protocol; and Internet Protocol, characterised in that there is an interface protocol layer AP between the Radio Access Network Application Part and the at least one of User Datagram Protocol for Transport Control Protocol.

In the accompanying drawings, the prior art is illustrated in figures 1 and 2 in which:-

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Figure 1 is a highly schematic diagram of a mobile radio telecommunications system;
and

Figure 2 illustrates a currently-used protocol stack.

The invention will be described by way of example only with reference to
Figures 3, 4 and 5 in which:-

Figure 3 illustrates the inventive protocol stack;

Figure 4a and 4 b illustrate prior art and inventive protocol stacks
implemented in a Base Station Controller in the Global System for Mobile telephones
(GSM); and

Figures 5a and 5b illustrate prior art and inventive protocol stacks
implemented in a Radio Network Controller in the Universal Mobile Telephone
System (UMTS).

In Figure 1 a GSM and UMTS mobile radio telecommunications system 10
comprises GSM and UMTS Core Networks (CN) 12, 14 which communicate over
respective radio access network interfaces 16, 18 with first and second Base Station
Controllers (BSC) 20, 22 each controlling a plurality of Base Transceiver Stations
(BTS) of which two only 24, 26 are shown. Each BTS controls at least one
telecommunications cell over an air interface 28, 30 and each cell may contain one or
more mobile users 32, 34.

The SS7 protocol is used to exchange radio access network signalling
messages between the CNs 12, 14 and the BSCs 20, 22.

Suppose now that CNs 12, 14 wish to communicate with BSCs 20, 22 through
the signalling interfaces 16, 18.

The current GSM signalling transport protocol arrangement for the signalling
interface 16 is shown in Figure 2.

The GSM BSC 20 use the signalling interface 16 that operates SCCP 42 which
offers to the Signalling Application 38 a number of Service Access Points (SAP) to
access its signalling transport services. Below the SCCP protocol layer 42 are three

Message Transfer Part (MTP) specialized functional layers 44 that offer network, data link and physical medium access services..

The UMTS BSC 22 to UMTS CN 14 signalling interface has a similar protocol arrangement.

5 As explained above, this combination of standard SCCP and standard UDP or TCP and IP protocols is not fully satisfactory for passage of signaling information. The invention consists of a protocol which adapts existing SS7 users to the underlying IP network protocol suite. Specifically the invention targets the Transport Control Protocol (TCP) and the User Datagram Protocol (UDP) as underlying protocols.

10 The proposed adaptation layer provides the user with SCCP SAPs and assumes TCP or UDP as underlying transport protocols. It compliments the functions already provided by the standard transport protocols (i.e. TCP or UDP) with additional functions to provide the user with the same quality of service the user would expect if a full SS7 stack were to be used instead.

15 Referring now to Figure 3, in a BSC 50 in which the invention is implemented, the signaling application 54 makes use of the SCCP services as in the prior art. The next protocol layer is an Additional Protocol (AP) 56 that provides SCCP services with specific functions. The Additional Protocols, in turn, make use of the transport layer services. As already clarified, the transport layer services can be provided by either TCP
20 or UDP. The UDP layer 58 (layer 4) is used for basic connection less messaging, over the Internet Protocol layer 60 (layer 3) which is used to provide network layer services. The protocol stack in BSC 52 is identical.

As an alternative to, or additional to, the UDP layer, the TCP may be provided.

The AP layer 56 is arranged to provide selected features of SS7 which are
25 interfaced with Internet Protocol, but by addition of a protocol, and not by addition of an application, as in the prior art.

An advantage of such an arrangement is that required features of SS7 can be retained, depending on the circumstances. More detailed implementation in the GSM and the UMTS will now be described.

30 Figure 4a shows the SS7 signaling protocol stack in a prior art BSC 20 in the GSM system. The protocols are BSSMAP (BSS Management Application Part) 70;

DTAP (Direct Transfer Application Part)(Distribution Function) 72; SCCP 74; and three layers of MTP 76.

Figure 4b illustrates the protocol arrangement in a BSC 78 according to the invention. The protocols BSSMAP 80 and DTAP 82 are retained. The next layer is the inventive Additional Protocol layer 56, followed by the UDP or TCP layer 58 and then IP 60.

Figure 5a shows the SS7 signaling protocol stack in the prior art UMTS BSC (equivalent from a gross functional standpoint to the Radio Network Controller in the UMTS access network). The protocol layers are RANAP (Radio Access Network Application Part) 84; SCCP 86; MTP-3b (MTP layer 3 according to Recommendation Q.2210); SAAL (Signalling ATM Adaptation Layer) 90; and ATM (Asynchronous Transfer Mode) 92.

Figure 5b illustrates the protocol arrangements in an RNC 94 according to the invention. The RANAP layer 96 is retained. The next layer is the inventive additional protocol layer 56 followed by the UDP and/or TCP layer 58, and IP 60.

The major achievement of this invention is the ability to provide SS7-like quality of service over standard TCP or UDP networks. The invention exploits transport and network service characteristics of the underlying transport protocols (UDP or TCP) and network protocol (IP) and reduces the implementation complexity typically required to adapt SS7 to the IP protocol suite. It allows both connection-oriented and connection-less mode of operation as described in ITU-T Recommendation Q.711. It also allows the use of the User Datagram Protocol when the characteristics of the user are compatible with the transfer characteristics provided by UDP. The main improvement on known existing solutions is the simplicity.

The novel Additional Protocol layer AP replaces the standard SS7 stack (or the relevant part of it) and functions with equivalent and more simple functions and provides the user the SCCP services with equivalent quality of service without requiring specific transport protocols or adaptation to existing transport protocol.

- 1 -

CLAIMS

1 A method of providing a user (32, 34) of a telecommunications network
with Signalling System Number 7 functionality, the network operating Internet Protocol
5 (60) and at least one of Transport Control Protocol and User Datagram Protocol and
having between the user (32, 34) and the Core Network (12, 14) of the
telecommunications network at least one interface (16, 18, 28, 30), characterised by
providing between the user (32, 34) and the Internet Protocol (60) an interface protocol
layer (AP 56), said interface protocol layer interfacing with at least one of Transport
10 Control Protocol and User Datagram Protocol whereby Signalling System Number 7
information is transmitted across said at least one interface.

2 A method according to Claim 1 in which the interface protocol layer (AP
56) is provided between a signalling application adopting the Signalling Connection
Control Protocol Service Access Points to access the signalling transport service and the
15 Internet Protocol (60).

3 A method according to Claim 2 in which the interface protocol layer (AP
56) provides additional functions not provided by either Transport Control Protocol or
User Datagram Protocol.

4 A telecommunications network comprising a Core Network (CN 12, 14)
20 and at least one network user (32, 34) and between the user and the Core Network at
least one interface (16, 18, 28, 30), the network operating Internet Protocol (60) and at
least one of Transport Control Protocol and User Datagram Protocol, characterised by
an interface protocol layer (AP 56) between the user (32, 34) and the Core Network (12,
14), said interface protocol layer being arranged to interface with at least one Transport
25 Control Protocol and User Datagram Protocol whereby Signalling System Number 7
functionality is provided to the user (32, 34).

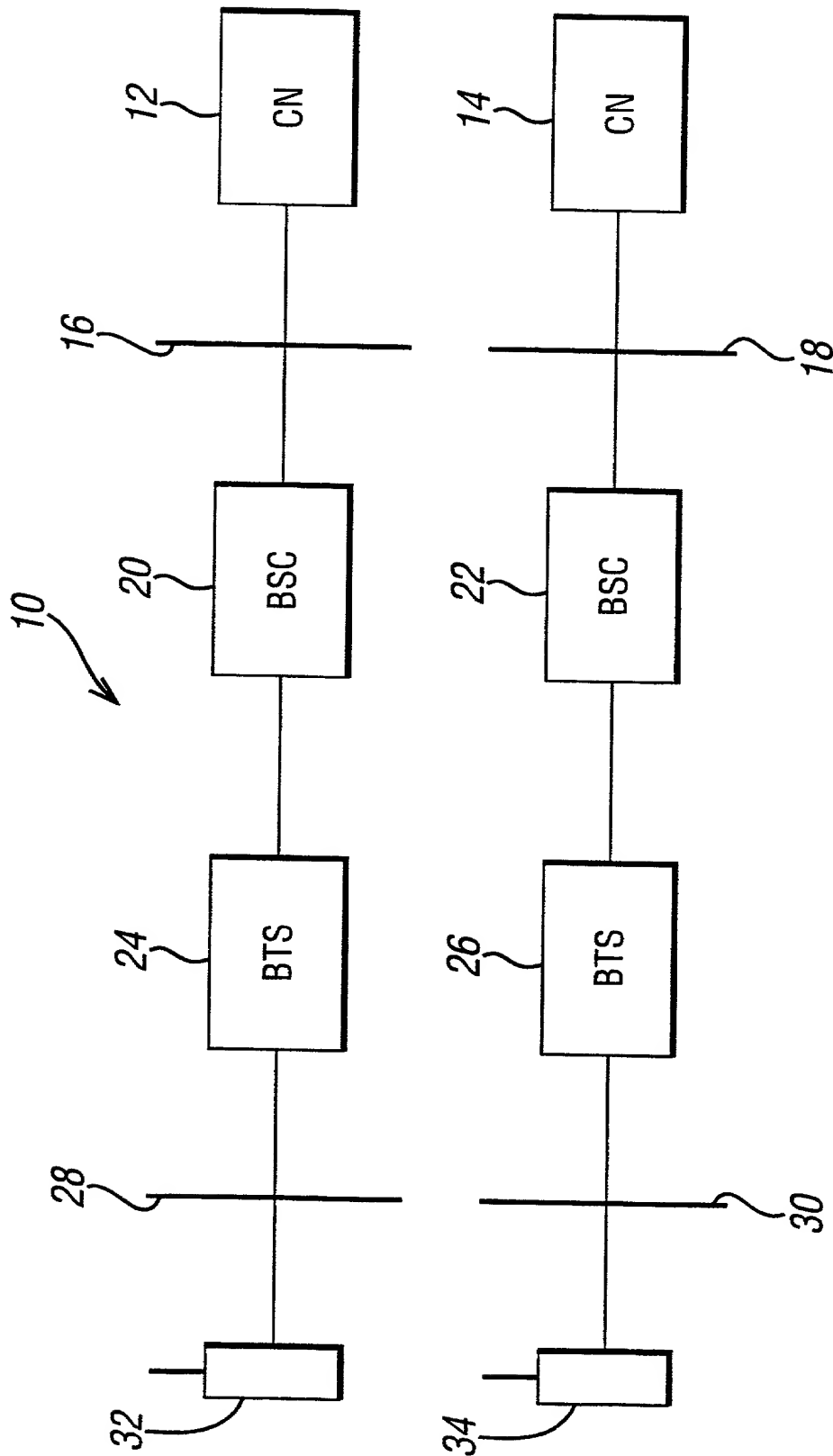
5 A Base Station Controller (78) for a telecommunications network having
a protocol stack comprising a BSS Management Application Part (70); a Direct Transfer
Application Part Distribution Function (82); at least one of User Datagram Protocol and
30 Transport Control Protocol (58); and Internet Protocol (60); characterised in that there is
an interface protocol layer (AP 56) between the Distribution Function (82) Transport
Control Protocol/User Datagram Protocol (58).

- 2 -

6 A Radio Network Controller (94) for a telecommunications network having a protocol stack comprising Radio Access Network Application Part (96); at least one of User Datagram Protocol and Transport Control Protocol (58); and Internet Protocol (60), characterised in that there is an interface protocol layer (AP 56) between
5 the Radio Access Network Application Part (96) and the at least one of User Datagram Protocol for Transport Control Protocol (58).

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FIG. 1



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FIG. 2

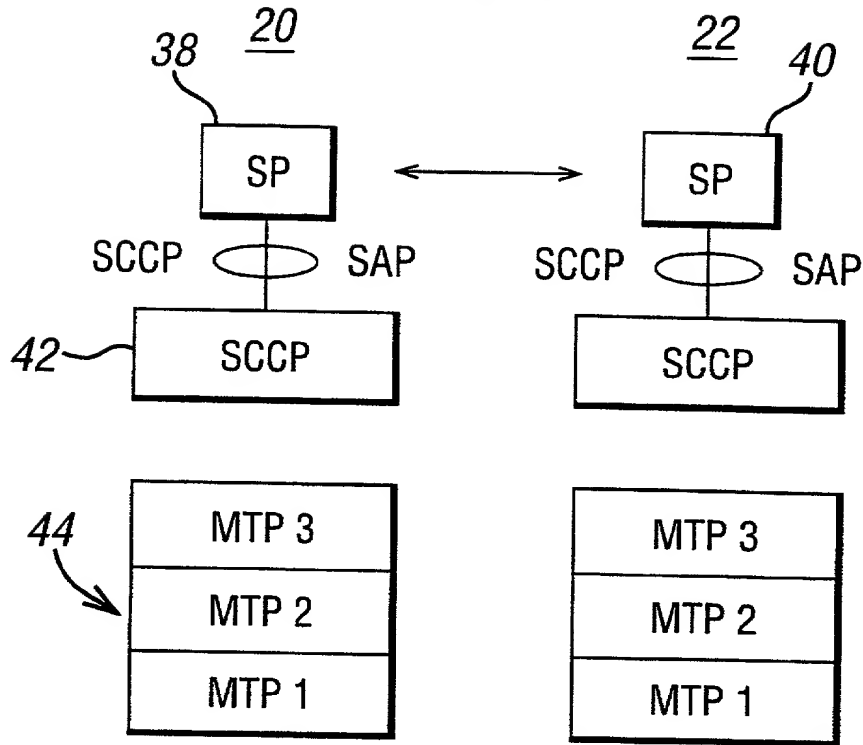
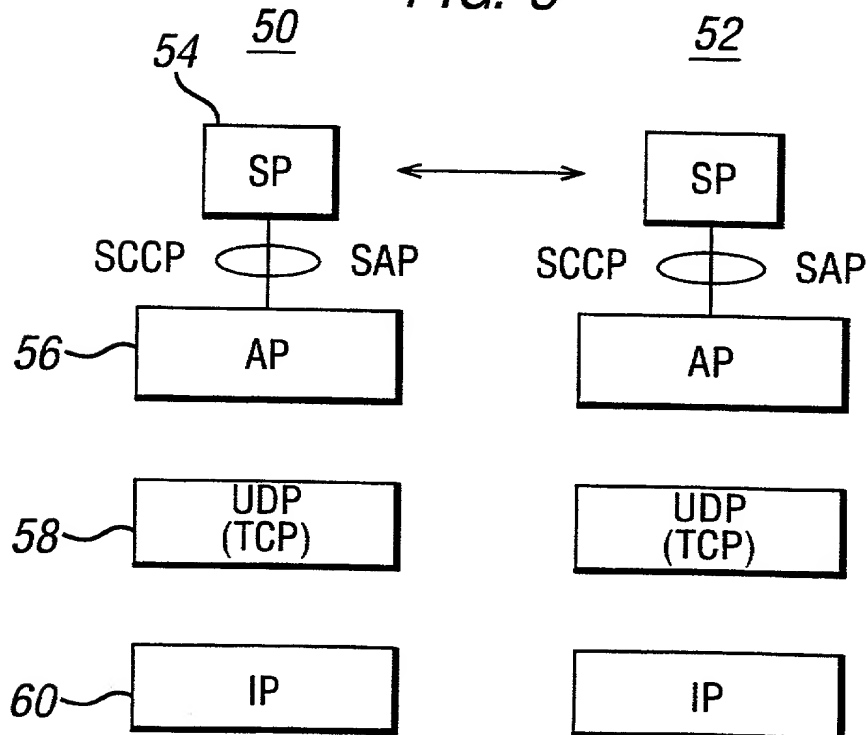
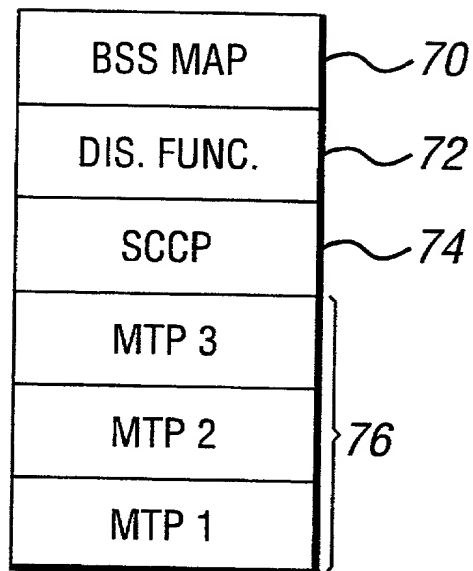
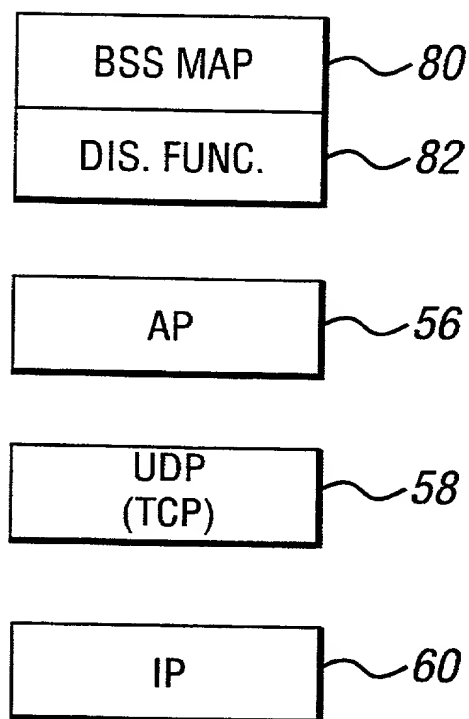
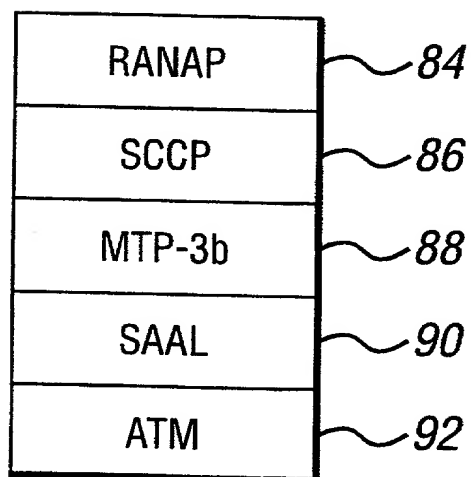
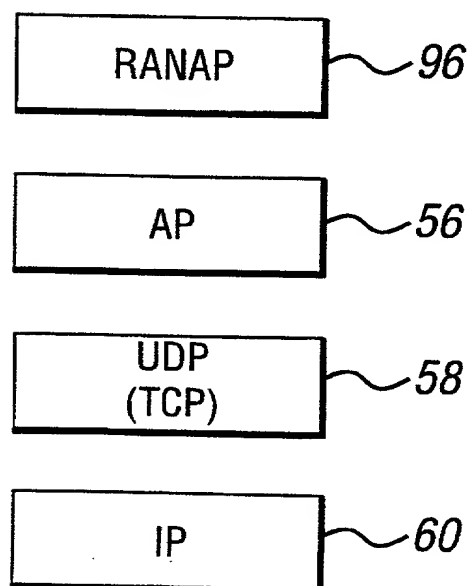


FIG. 3



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*FIG. 4a*BSC 20*FIG. 4b*BSC 78*FIG. 5a*RNC*FIG. 5b*RNC 94

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **Telecommunications Signalling Using The Internet Protocol** the specification of which

[] is attached hereto

OR

[X] was filed on 9/14/01 and granted Application Serial Number 09/936673.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment, if any, specifically referred to in this oath or declaration.

I acknowledge the duty to disclose all information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

GB Application No.9905835.6 Filed March 15, 2000

I hereby claim the benefit under Title 35, United States Code, 120 of any foreign application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

International

Application No.
PCT/GB00/00936

Filing Date
14TH March 2001

Status
Pending

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States

Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) with full power of substitution and revocation, to prosecute said application, to make alterations and amendments therein, to receive the patent, and to transact all business in the Patent and Trademark Office connected therewith:

Kenneth M. Brown	(Reg. No. <u>37590</u>)
Donald P. Dinella	(Reg. No. <u>39961</u>)
Martin I. Finston	(Reg. No. <u>31613</u>)
Barry H. Freedman	(Reg. No. <u>26166</u>)
Julio A. Garceran	(Reg. No. <u>37138</u>)
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Gregory C. Ranieri	(Reg. No. <u>29695</u>)
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Ronald D. Slusky	(Reg. No. <u>26585</u>)
Ozer M.N. Teitelbaum	(Reg. No. <u>36698</u>)
Charles L. Warren	(Reg. No. <u>27407</u>)
Eli Weiss	(Reg. No. <u>17765</u>)

I hereby authorize these attorneys to insert in the above blanks the filing date and application serial no. when known.

Please address all correspondence to the Docket Administrator (Rm. 3C-512), Lucent Technologies Inc., 600 Mountain Avenue, P. O. Box 636, Murray Hill, New Jersey 07974-0636.
Telephone calls should be made to David Williams by dialing 011-44-208-504-2824.

Full name of 1st joint inventor: Mauro Costa

100 Inventor's signature [Signature]

Date 05/12/2001

Residence: Pavia, Italy ITX

Citizenship: Italy

Post Office Address: via Dabusti 55
Casteggio 27045
Pavia
Italy

Full name of 2nd inventor: Emiliano Antonio Mastromartino

200 Inventor's signature _____

Date _____

Residence: Milano, Italy ITX

Citizenship: Italy

Post Office Address: Via Moscova 60
Milano
20100
Italy

Full name of 3rd inventor: Luca Salgarelli

300 Inventor's signature _____

Date _____

Residence: Hoboken, Hudson, United States of America NJ

Citizenship: Italy

Post Office Address: 1300 Clinton Street
Apt. 324
Hoboken
United States of America

Please address all correspondence to the Docket Administrator (Rm. 3C-512), Lucent Technologies Inc., 600 Mountain Avenue, P. O. Box 636, Murray Hill, New Jersey 07974-0636. Telephone calls should be made to David Williams by dialing 011-44-208-504-2824.

Full name of 1st joint inventor: Mauro Costa

Inventor's signature _____ Date _____

Residence: Pavia, Italy

Citizenship: Italy

Post Office Address: via Dabusti 55
Casteggio 27045
Pavia
Italy

Full name of 2nd inventor: Emiliano Antonio Mastromartino

Inventor's signature Emiliano Antonio Mastromartino Date 14/11/2001

Residence: Milano, Italy

Citizenship: Italy

Post Office Address: Via Moscova 60
Milano
20100
Italy

Full name of 3rd inventor: Luca Salgarelli

Inventor's signature _____ Date _____

Residence: Hoboken, Hudson, United States of America

Citizenship: Italy

Post Office Address: 1300 Clinton Street
Apt. 324
Hoboken
United States of America

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Full name of 1st joint inventor: Mauro Costa

Inventor's signature _____ Date _____

Residence: Pavia, Italy

Citizenship: Italy

Post Office Address: via Dabusti 55
Casteggio 27045
Pavia
Italy

Full name of 2nd inventor: Emiliano Antonio Mastromartino

Inventor's signature _____ Date _____

Residence: Milano, Italy

Citizenship: Italy

Post Office Address: Via Moscova 60
Milano
20100
Italy



Full name of 3rd inventor: Luca Salgarelli

Inventor's signature  _____ Date 6/13/2001

Residence: Hoboken, Hudson, United States of America

Citizenship: Italy

Post Office Address: 1300 Clinton Street
Apt. 324
Hoboken
United States of America



MARY L. BENSON
Notary Public of New Jersey
My Commission Expires June 3, 2004

Full name of 4th inventor: Sutha Siyagnanasundaram

Inventor's signature

Date 11/6/01

Residence: Marlborough, Wiltshire, Great Britain

GBX

Citizenship: Sri Lanka

Post Office Address: 30 Bath Road
Fyfield
Marlborough
SN8 1PX
Great Britain

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